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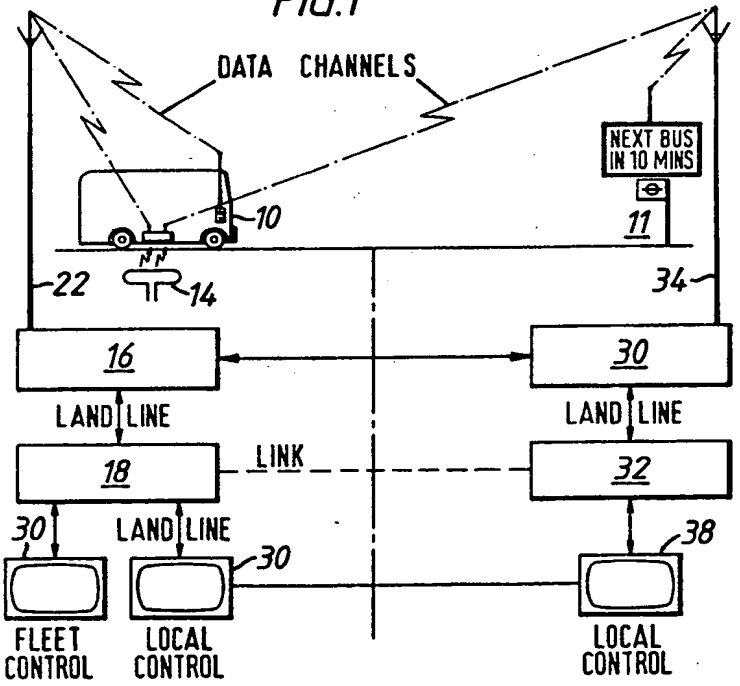
(54) Transportation system

(57) A transportation system in which a plurality of passenger carrying vehicles 10 convey passengers over a network of routes between embarkation and disembarkation points. The position of the vehicles along the routes is sensed periodically and the sensed information transmitted to a control 30, 32. The control processes the information and then transmits to apparatus at each embarkation point data relating to the expected arrival times of the vehicles.

FIG.1



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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

FIG.1

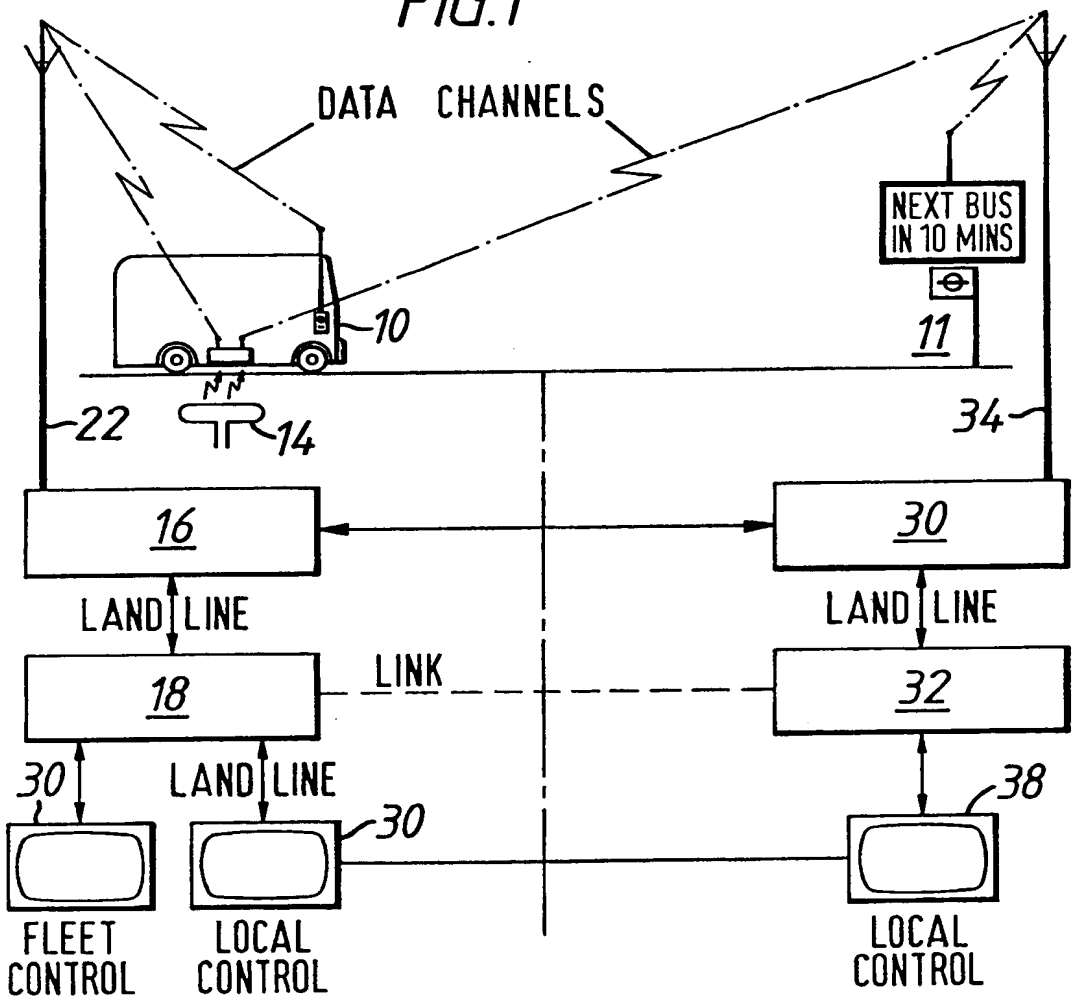
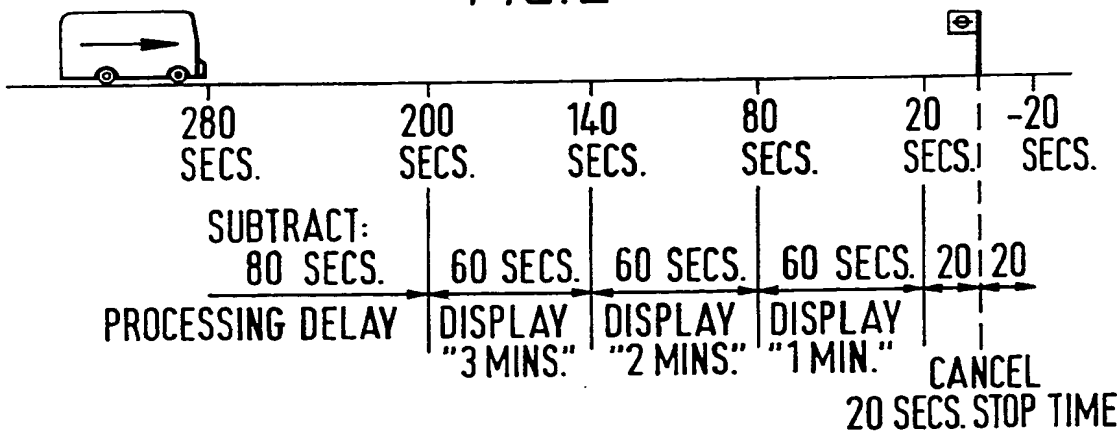


FIG.2



SPECIFICATION

Transportation system

This invention relates to transportation systems. In particular the invention relates to transportation systems in which a plurality of passenger carrying vehicles convey passengers over a network of routes.

In a bus transportation system, a plurality of buses convey passengers over a network of routes between embarkation and disembarkation points. It has been proposed to monitor the movement of buses within the network, by sensing the position of buses along the length of each route and to transmit information regarding each bus to one or more control stations. The sensing can be carried out by equipment mounted on board the bus or by equipment fixed at the roadside or installed elsewhere or by a combination of these. This information can be processed to provide an indication of the state of the network. If necessary controllers at the control station can relay instructions or information to the buses.

It has now been appreciated that this arrangement can be extended to provide information for passengers at the embarkation and disembarkation points.

According to the present invention there is provided a transportation system in which a plurality of passenger carrying vehicles convey passengers over a network of routes between embarkation and disembarkation points, said routes having a plurality of appropriately located sensing means for sensing said vehicles, processing means for receiving data indicative of sensed vehicles from said sensing mean, at least some embarkation and/or disembarkation points being provided with apparatus which is responsive to signals received from said processing means to provide information relating to said vehic;,es, said information including expected arrival times for vehicles at said embarkation and disembarkation points, and wherein said processing means is arranged to compute said expected arrival times on the basis of currently received data and previously stored data.

Each sensing means may be arranged to sense signals transmitted by a vehicle as the vehicle passes thereby, the signal transmitted by each vehicle incorporating a code indicative of that particular vehicle.

Data may be transmitted from each sensing means to said processing means by a radio link. Alternatively the data may be transmitted via communications cables.

Sensing means provided on the vehicles may receive signals transmitted from roadside or other equipment and may combine the information represented by these signals with information from other on board sensing means for use in location of the vehicle. The combined information may be transmitted to the processing means directly or via roadside equipment.

The processing means may comprise one or more computers. The computer or computers may be located at one central location. Alternatively there may be several computers distributed throughout the network.

Said apparatus may comprise visual display apparatus. The information may be transmitted to said visual display apparatus by way of radio links. The information may include expected arrival times of said vehicles.

The invention will be described now by way of example only with particular reference to the accompanying drawings. In the drawings Figure 1 is a block schematic diagram of a transportation system in accordance with the present invention, and Figure 2 illustrates the system in operation.

The transportation system illustrated schematically in the drawing is one in which a plurality of buses such as that shown at 10 operate over a network routes conveying passengers between a plurality of embarkation and disembarkation points 11 hereinafter referred to as bus-stops. The network of routes is provided with a plurality of sensors such as a road loop beacon shown at 14 for sensing the location of the buses 10. Each bus 10 has transmitting and receiving equipment which when it passes a beacon, transmits an appropriate signal to the beacon. This signal incorporates a code indicative of the particular bus. The bus or the beacon then relays signals indicative of the bus and its location to a station 16. As shown in the drawing the communication between the beacon 13 and the station 16 is a radio type link although it could also be a communications cable. Alternatively as each bus passes the beacon it may receive coded signals from the beacon. These signals may include a code indicative of the particular beacon. The equipment mounted on the bus may combine the received information with other information from on board sensors such as distance travelled since passing a beacon or since the last transmission. This combined information can then be transmitted to the processing means by a radio or other link. This can be provided via the transmitting and receiving apparatus carried by the bus and aerial 22 and station 16. It could also be transmitted to station 30. Each station 16 is linked to a computer 18 which receives data indicative of bus information for appropriate processing. The computer can be used to provide information fmr controllers who can access the computer via control terminals shown at 20. In addition the computer can be used to generate information for transmission to the buses e.g. information to a driver. This can be provided via the station 16 and aerial 22 for reception by the transmitting and receiving apparatus carried by the bus.

Associated with the station 16 is a further station 30 which can be a separate station or part of the station 16. This station 30 can receive the data received at the station 16 for transmission to a computer 32. The computer 32 receives the data indicative of bus movements and locations, processes that data, and assembles messages for transmission via the station 30 and an aerial 33 to a suitable display apparatus located at each bus-stop 11. This information can for example be a forecast of the expected arrival time of identified buses. In addition the computer 32 can recieve commands fed in from a control terminal 38.

Each bus 10 has associated with it a unique code and data indicative of this code is transmitted to a road loop beacon as the bus passes that beacon. Thus data indicative of the position of a particular bus can be transmitted via an associated station 16, 30 to the computer 18, 32. The data can also be transmitted directly from the bus to the station 16, 30 without passing via the beacon. This data is processed in the computer 18 for use by traffic conorollers. The computer 32 processes the information so that it can be used to generate messages for transmission to the display apparatus located at each bus-stop 11. The information can take the form for example of estimated times of arrival of particular buses. If necessary information can be input manually into the computer 32 via the control terminal 38 in order to take account of delays caused by for example breakdowns or roadworks.

The process of forecasting arrival times is essentially that of converting distance into time. As the progress of a bus is monitored on a regular basis its distance from a particular stop is known. Then knowing its rate of progress the expected time of arrival can be evaluated. However it will be appreciated that the relationship between distance and time is not the same for all sections of network nor is it constant throughout an extended length of time. For this reason the forecasting method incorporates a bus progress monitoring technique which continually updates estimates of running times between defined points along the route.

For example buses can be polled by the central computer approximately every 60 seconds. The location of a particular bus is defined by the identity of the last beacon which it passed and the number of distance increments traverse since passing the beacon. Thus a route can be considered as several sections of road each of a particular length. Average running times over individual road sections in a series are continuously updated by monitoring the progress of each bus along that route. Applied to each bus the monitoring/update procedure involves calculating the average running time per distance increment for that bus since the previous poll. Running time records along specific road sections traversed by the bus can then be updated by calculating the weighted average of previous and latest average running times. Other factors can be taken into account such as the comparative journey speeds on a particular bus and the actual time interval (or headway) since the preceding bus. The inclusion of actual information on the running times of this bus and preceding buses can greatly increase the accuracy of time of arrival estimates. This data is then used to generate the necessary information for driving the displays located at each bus-stop.

There are several ways in which this can be achieved and the following example illustrates the principle. Consider a bus route from Grove park to Marble Arch. Starting with zero odometer increments at Grove Park (Lewisham stop) and peckham West (Victoria stop), the northbound route was taken as three series of specific sections of road with each section 80 feet in length and defined as an incremental number of odometer increments from the starting point. The three series were:

(a) Grove Park to New Cross,

(b) Hither Green to Catford (calibrated against (a) at Catford Broadway), and

(c) Peckham West to Marble Arch.

Stop locations were also defined as numbers of odometer increments from starting points. Bus locations expressed as odometer increments past specified road loops were recalculated as odometer increments from Grove park or peckham West.

Average running times over specific sections of route were monitored by simply keeping track of previous and latest bus locations, and the time between polls.

For instance: previous location = road section 33 (33 increments from starting point) latest location = road section 35 time between polls = 66 seconds average progress over sections 33 to 45 was 6 seconds/section.

Weighted average progress over these sections was then updated in the following way:

sections 33 to 45 : 0.9* old value + 0.1* new value

sections 35 to 44 : 0.8* old value + 0.2* new value

However, if previous and latest bus locations are equal (little or no progress) the update procedure is aborted. This can cause bias in the case of buses delayed in very heavy traffic, but in the majority of cases no progress means mechanical problems etc., and so requires screening from the normal update procedure.

To estimate the time to arrival at a stop the processor sums the average running times over all the "road sections" between the bus and the stop. However, certain other factors can be taken into account. These are:

(a) headway of next bus;
(b) delay in processing time;
(c) message cancellation;
(d) no reply to poll.

(a) *Headway*

Arrival times can be under-estimated if headways of the next bus are not being taken into account. An approximate correction is to increase times of arrival by 10%.

(b) & (c) *Delay in Processing/Message Cancellation*

Any delay between receiving bus location information and updating displays needs to be subtracted from the estimated time to arrival. In additiion, with location polls only every minute and information polling constrained to following location polling, the best strategy for message cancellation is to cancel up to 20 seconds early if necessary. This is illustrated in Figure 2.

(d) *No Reply to Poll*

This is a special case. The last estimated time to arrival based on *known* location is reduced by the time *since* that location was reported. In other words, normal progress was assumed.

As described the computers 18, 32 are located at one central location. It will be appreciated that there could be several computers distributed throughout the network.

Also as described communication between the stations 16, 30 and the beacons 14 and bus-stops 11 is by way of radio links. The communication could be provided via communications cables.

The information on the locations of the vehicles may be used to provide information on the buses that will arrive at the stop to passengers waiting at bus stops or at other places. This information may include for each route or service the time until the next buses will arrived bases on actual traffic and other conditions and updated estimates of journey times from the buses current location to the bus stop. Where a route or service may serve more than one destination, information can be given on the actual destination of these buses. Further information can be given on events and traffic conditions which may delay or disrupt the operation of the service at that time or in the future. Information on the numbers of seats available on the bus may also be provided.

CLAIMS

1. A transportation system in which a plurality of passenger carrying vehicles convey passengers over a network of routes between embarkation and disembarkation points, said routes having a plurality of appropriately located sensing means for sensing said vehicles, processing means for receiving data indicative of sensed vehicles from said sensing means, at least some embarkation and/or disembarkation points being provided with apparatus which is responsive to signals received from said processing means to provide information relating to said vehicles, said information including expected arrival times for vehicles at said embarkation and disembarkation points, and wherein said processing means is arranged to compute said expected arrival times on the basis of currently received data and previously stored data.

2. A system as claimed in claim 1 wherein correction or weighting factors are applied to said data.

3. A system as claimed in claim 1 or claim 2 wherein each sensing means is arranged to sense signals transmitted by a vehicle as the vehicle passes thereby, the signal transmitted by each vehicle incorporating a code indicative of information relating to that particular vehicle.

4. A system as claimed in any one of claims 1 to 3 wherein data is transmitted from each sensing means to said processing means by a radio link.

5. A system as claimed in any one of claims 1 to 3 wherein the data is transmitted via communications cables.

6. A system as claimed in any preceding claim wherein sensing means are provided on each vehicle to receive signals from roadside or other equipment, said sensing means being arranged to combine the information representated by those signals with information from other on board sensing means for use in location of the vehicle, said combined information being transmitted to said processing means.

7. A system as claimed in any preceding claim wherein the processing means comprises one or more computers.

8. A system as claimed in claim 7 wherein the computer or computers are located at one central location.

9. A system as claimed in claim 7 wherein there are several computers distributed throughout the network.

10. A system as claimed in any preceding claim wherein said apparatus comprises visual display apparatus.

11. A system as claimed in claim 10 wherein the information is transmitted to said visual display apparatus by way of radio links.

12. A transportation system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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